S-E-C-R-E-T

AN ANALYSIS AND APPRAISAL OF THE CARGO CHUTE LOCATOR SYSTEM ENGINEERING MODEL (RS-8)

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25X1

3 March 1954

S-E-C-R-E-T

I. INTRODUCTION

An engineering model of the Cargo Chute Locator System constructed by [redacted] was submitted to the Analysis and Appraisal Group of the Research and Development Branch Laboratory, Commo Engineering, during the latter part of 1953. The System was tested in order to determine its operational characteristics and fulfillment of Task Outline Specifications. 25X1

This report contains an outline of the tests performed, the results of these tests, and a comparison of results with the Specifications as stated in the Task Outline.

II. SUMMARY

The engineering model of the Cargo Chute Locator System - RS-8 is a two unit system employing a self-pulsed transmitter and a super-heterodyne receiver-direction finder. The unit operates on one of six pre-set channels in the 45 megacycle range.

The transmitter, designed as a "one shot" unit, is approximately 10 1/2" x 7 1/4" x 4 1/2" and weighs 7.7 pounds. It is strapped to the cargo pack and has its four quarter-wave antennas fastened to the pack in a radial manner. The unit is relatively rugged and should withstand the effects of a parachute drop.

The receiver is 7 1/8" x 5" x 2" in size and weighs about 2 pounds. It incorporates a directional loop antenna molded into its plastic case. The receiver is worn as is a holster on the right hip. This unit should also withstand a parachute drop when worn by the operator.

The system fails to meet the specification for operation. The Task Outline requires operation over a quarter mile range under any conditions of weather, terrain, or time. The model tested failed to operate satisfactorily over distances greater than 300 yards under ideal line-of-sight conditions. The deficiency appears to be in the receiver unit, which lacks overall gain sufficient to provide satisfactory operation over the required range. The system's direction finding arrangement is very satisfactory, employing a unidirectional receiver and an omni-directional transmitter.

The system would probably provide adequate service if the present transmitter unit were combined with a receiver incorporating the present unit's direction finding ability with a greater overall gain.

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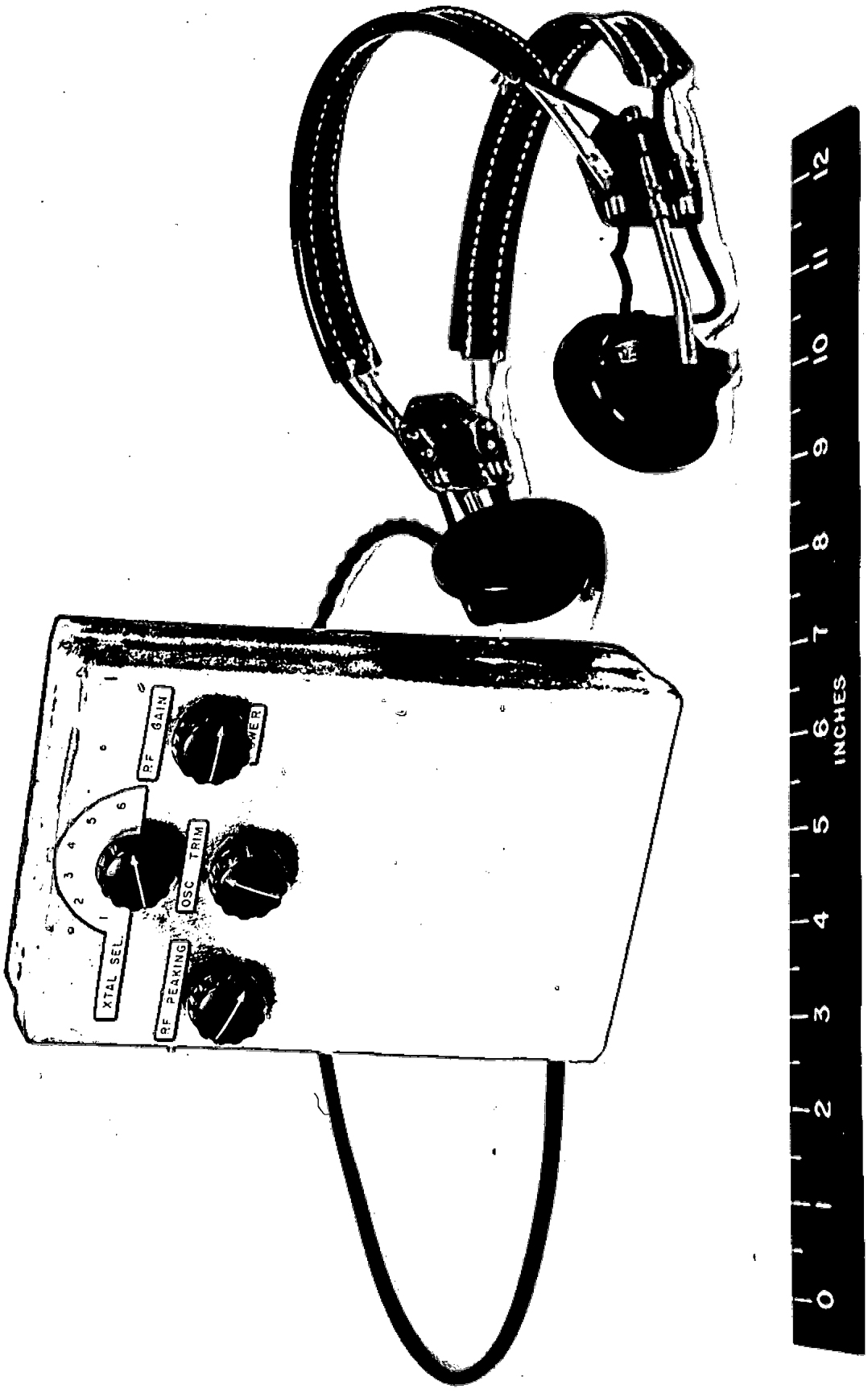


1. MECHANICAL SECTION

1.1. SIZE AND WEIGHT

1.1.1. TRANSMITTER

Size : 10 1/2" x 7 1/4" x 4 1/2"
Weight: 7.7 pounds (including batteries)

1.1.2. RECEIVER

Size : 7 1/8" x 5" x 2" (excluding knobs, etc.)
Weight: 2 pounds (including batteries)

1.2. DESCRIPTION

The transmitter is a self-contained unit housed within a laminated plastic case. The case is flanged to provide ruggedness. One end of the unit is recessed to provide protection for the "On-Off" switch. The case is fitted with four brackets to provide a means of fastening the transmitter to the cargo pack. The antenna, which is fastened radially to the cargo, terminates in a stud and wing nut which protrude from the side of the case. The entire transmitter unit is waterproofed by means of gasket seals on the end plates, a rubber "boot" over the toggle switch, and a Cannon plug on the battery pre-heating circuit. The internal components are shock mounted in rubber. The crystal is completely enclosed in a padded aluminum container. The latter can be opened easily for replacement of the crystal. Since the transmitter is intended primarily for "one shot" operation, no fungus proofing has been used.

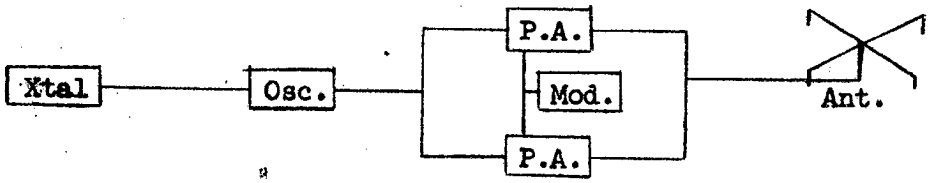
The receiver is also contained in a laminated plastic container. The cover is of the friction type. The direction finding loop antenna is molded into the side portions of the case. The receiver is equipped with four controls: the crystal selector switch, RF peaking control, oscillator trimmer control, and RF gain combined with an "On-Off" switch. The manufacturer recommends a false front cover over the controls to meet sterility and burial specifications. The unit is shower-proof. Future models are to incorporate anti-fungus and tropicalization treatments. A short length of phone cord is an integral part of the receiver unit. A standard type of Army Signal Corps headphones is also supplied by the manufacturer.

2. ELECTRICAL SECTION

2.1. CIRCUITRY

2.1.1. TRANSMITTER

The transmitter circuitry consists mainly of four 5906 subminiature tubes combined as shown in the following block diagram:



The series connected filaments of the four tubes are supplied by three JAN BA-53 67.5 volt batteries. The resulting voltage is approximately 50 volts per filament. The 5906 has a nominal filament voltage of 26.5. An additional JAN BA-53 battery is used in series with the others to provide a 270 volt "B" supply. Grid bias for the paralleled power amplifiers is supplied by a JAN BA-261-U 22.5 volt battery.

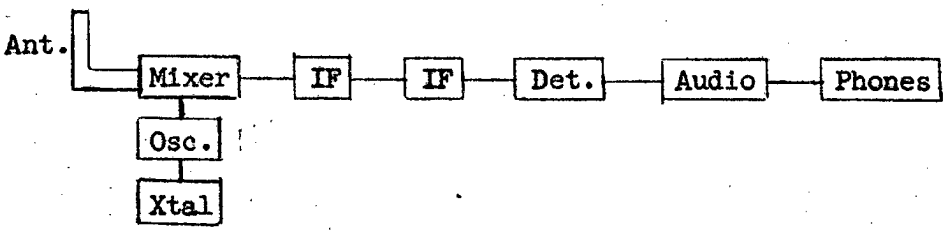
The crystal controlled oscillator is of the self-pulsing type. Both the grid and plate of the oscillator are provided with slug tuning. The final plate is also tuned by a variable slug. A neon bulb is used as an indicator for determining resonance. The final is screen modulated by a simple audio oscillator.

The antenna is loosely capacity coupled to the final tank circuit.

A separate circuit supplied through an external Cannon plug provides power to three 28 volt heating elements surrounding the battery compartment. The heaters are thermostatically controlled at 24°C.

2.1.2. RECEIVER

The receiver circuit is a conventional superheterodyne with the following functional stages:



The mixer and oscillator are combined within a 1V6 tube; the IF's are 5678's; the detector is a 1N34; and the audio is a 2E36. The tube filaments are connected in parallel across two JAN BA-42 1.5 volt batteries. The receiver "B" voltage is supplied by three series connected JAN BA-261-U 22.5 volt cells.

The loop antenna is inductively coupled to the mixer control grid tuned circuit. This circuit is tuned by means of the external RF peaking control. The oscillator trim control varies the capacity in the oscillator tuned circuit. The IF's, mixer, and oscillator are all tuned by pre-set variable slugs. The RF gain control varies the screen voltage applied to the IF tubes. The plate supply to the audio tube is series fed through the headphones.

2.2. ELECTRICAL TESTS

2.2.1. TRANSMITTER

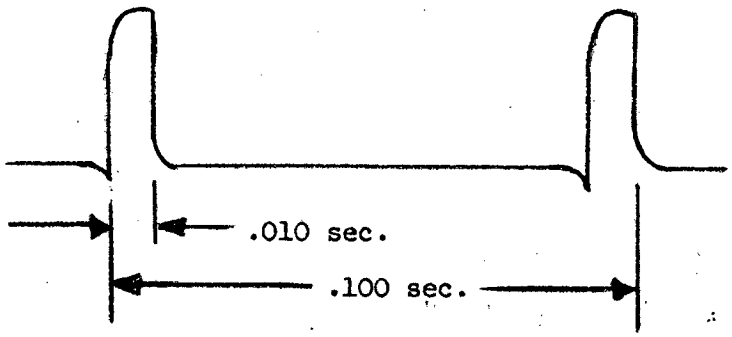
2.2.1.1. POWER OUTPUT

The transmitter was set up to operate at the rate of 10 pulses a second with approximately a 10% duty cycle. The output voltage across a 50 ohm noninductive load was measured by means of a calibrated oscilloscope. The peak power output under these conditions was approximately 2 watts.

The test was repeated after the performance of field tests, and the results indicated a substantial loss in peak power output. This loss was attributed to the decrease in filament emission in the tubes. The tubes operate on 200% of the rated filament voltage.

2.2.1.2. WAVE SHAPE

The output wave, as viewed on the oscilloscope, was of the following general shape.



2.2.1.3. ANTENNA

The antenna consists of four quarter wave elements in quadrature, fed from a common terminal. Field intensity measurements indicate that the configuration used is practically omnidirectional in output. For specific results of field intensity measurements and radiation pattern see paragraph 2.3.3.

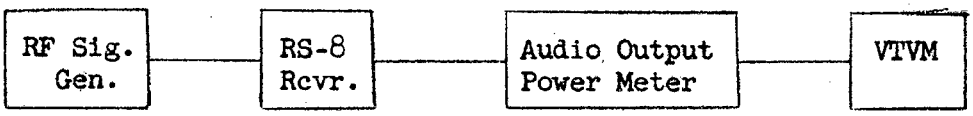
2.2.1.4. BATTERY LIFE

No specific test of battery life was conducted. However, a log of operating time shows that the transmitter fails to perform satisfactorily due to decrease in "A" battery output after about 2.5 hours of operation. The ambient temperature during the period of operation was approximately 70°F. Since the "A" supply is also used to provide a part of the "B" voltage, the latter also falls below operating requirements after 2.5 hours of operation. The 22.5 volt "C" battery was not tested for life.

2.2.2. RECEIVER

2.2.2.1. SENSITIVITY

Set-Up:



2.2.2.1.1. RAW NOISE

Using the above set-up with all receiver controls set at maximum and no input signal, the measured power output was in the order of 5 micro-micro-watts. For all practical purposes this figure is negligible; hence a 10 db signal to noise ratio reading is meaningless.

2.2.2.1.2. RAW SENSITIVITY

Using the same set-up, a 1000 cycle tone, 30% modulated, was introduced to the receiver at the antenna terminals (the antenna disconnected). The voltage input required to produce a nominal power output of .005 milliwatts using the headset provided (2,000 ohms) as a load was 30 microvolts. This power produced a comfortable audio output level. Using a 20,000 ohm load, the audio output produced was approximately .01 milliwatts with the same 30 microvolt input. This indicates a considerable deviation from the specified load for this type tube. The recommended load for a 2E36 tube operating under similar conditions is 75,000 ohms.

2.2.2.2. AUDIO OUTPUT

The same set-up was used to determine the maximum audio power output obtainable under various audio circuit loads. A maximum of 10 milliwatts was obtained when a 20,000 ohm load was used and 4 milliwatts obtained using an 8,000 ohm load. In each case the input was approximately 45,000 microvolts.

2.2.2.3. BATTERY LIFE

No specific battery life tests were conducted on the receiver unit. A log of receiver "on" time indicates that the batteries supplied produce sufficient output to power the unit for at least 5 hours.

2.3. FIELD TESTS

2.3.1. GENERAL OPERATION

The system, as received from the manufacturer, was incapable of satisfactory operation over distances greater than 50 yards. Upon investigation it was found that the receiver IF's were misaligned approximately 300 kc. Correction of this produced the following results.

Under ideal line-of-sight operating conditions, the system functioned satisfactorily within a 300 yard radius. At distances greater than this, the receiver failed to produce an audible signal. When adverse conditions such as buildings, hills, trees, and brush were encountered, the effective range was decreased to 180 yards.

2.3.2. DIRECTION FINDING

The system performed satisfactorily from a direction finding standpoint. The receiver, when worn in the position of a pistol holster on the right hip, indicates a strong signal when the operator is facing the transmitter. Wearing the receiver on the front or left side results in improper directional indication. The body capacity effect of the headphone cord was greatly reduced by replacing the cord supplied with a shielded type. Repeated field tests showed that the receiver was capable of direction finding any audible signal it received.

2.3.3. FIELD STRENGTH

Tests performed with a Stoddart Field Intensity Meter (model NMA-5A) indicate that the transmitter output field is essentially omnidirectional. There was no appreciable change in field strength around a circumferencial path with the transmitter at its center. The orientation of the antenna with respect to the earth and the receiving unit also appears to have little bearing upon the radiated field strength. Typical field strength readings indicate 40 microvolts/meter at 1/8 mile, 30 microvolts/meter at 1/4 mile, and 15 microvolts/meter at 3/8 mile. All readings were made during line-of-sight operation using the "quasi-peak" position on the field intensity meter.

2.3.3. FIELD STRENGTH (Continued)

Obstructions, such as buildings, metal fences, hills, etc., caused definite "shadow effects".

Tests using a Hammarlund SP-600 receiver indicate that the transmitter signal can be detected by it over distances as great as 4 or 5 miles, even when line-of-sight operation is not maintained.

3. COMPARISON TO SPECIFICATIONS OF TASK OUTLINE

The following is a comparison of the engineering model tested to the specifications contained in the "Task Outline for a Cargo Chute Locator System" dated 17 April 1952.

The decimal references given are paragraph numbers from the task outline.

5. General Characteristics

5.1. The system shall perform its function satisfactorily over a minimum distance of one quarter of a mile regardless of the terrain, weather, and time of day. It shall be as simple to operate and as foolproof as the state of the art permits. The mission shall not be detectable by persons not using special detecting devices.

The system fails to meet this specification in that it does not operate satisfactorily over distances greater than 180 yards in a region covered with brush and trees (see paragraph 2.3.1.).* In addition, the system is readily detectable on receivers capable of scanning the 45 mc range. The characteristic signal could be picked up on a Communications type receiver over about a 5 mile radius.

6. Special Characteristics

6.1 Transmitter

6.1.1. Weight - The total weight of the unit will be under five pounds.

The transmitter with batteries weighs 7.7 pounds.

6.1.2. Size - The size of the unit will be reasonable for equipment of this type.

Unit is 10 1/2" x 7 1/4" x 4 1/2".

6.1.3. Form Factor - The form factor is not critical but the unit must be completely self-contained and consist of a single box.

The transmitter unit is self-contained and would not protrude excessively from a cargo pack.

* This report

3. COMPARISON TO SPECIFICATIONS OF TASK OUTLINE (Continued)

6.1.4. Ruggedness - The unit should be capable of functioning during and after a normal parachute drop.

The unit appears to be reasonably rugged. The manufacturer states that future models will have the components molded in an ethoxyline resin plastic block.

6.1.5. Service Life - Approximately thirty minutes of operation after the drop is expected.

Unit operated satisfactorily for approximately 2.5 hours (see paragraph 2.2.1.4.).*

6.1.6. Frequency Stability - This factor will be dependent upon the requirements of the system as formulated.

The transmitter oscillator frequency is crystal controlled and hence can be considered stable.

6.1.7. Emission - A-2 emission is suggested although the requirement is for a distinctive signal.

Modulation is superimposed upon a square wave envelope which is derived from a self-pulsing oscillator (see paragraph 2.2.1.2.).*

6.1.8. Channels - One pre-set channel will be required.

The transmitter is equipped with one changeable pre-set channel.

6.1.9. Construction - Since this will be considered a "one-shot" operation, no waterproofing, fungus proofing or tropicalization will be required. It is contemplated that the unit will be sealed in cans during storage.

The unit is waterproof, assuming operation from swamp or marsh areas (see paragraph 1.2.).*

6.1.10. Finish - The external finish will be camouflaged and nonreflecting.

The transmitter meets these requirements.

* This report

3. COMPARISON TO SPECIFICATIONS OF TASK OUTLINE (Continued)

6.2. Receiver

6.2.1. Weight - The total weight of Component "B" will be less than five pounds.

The receiver, including batteries, weighs two pounds.

6.2.2. Size - The unit will not exceed thirty-six cubic inches in volume, exclusive of antenna.

The unit occupies approximately 70 cubic inches in volume. This includes the antenna.

6.2.3. Form Factor - The unit shall be designed to be carried on the person of the chutist and be operated by him while in motion.

The unit is designed to be worn as a pistol holster and could be operated while the chutist was in motion.

6.2.4. Controls - This unit shall have a minimum number of controls. Once placed in operation it should require no adjustments until the sensing operation begins. The chutist's hands must be free during descent but he will be able to make tuning adjustments after he is on the ground.

The unit is supplied with four external controls (see paragraph 1.2.).* The "oscillator trim" control is considered unnecessary. The channel selector, RF peaking, and gain controls are functional and required.

6.2.5. Ruggedness - Very rough treatment should not impair the operation of this unit.

The receiver is reasonably rugged (see paragraph 1.2.).*

6.2.6. Service Life - One set of batteries should give a minimum of two hours of continuous operation.

Receiver battery life was found to be in excess of five hours (see paragraph 2.2.2.3.).*

* This report

3. COMPARISON TO SPECIFICATIONS OF TASK OUTLINE (Continued)

6.2.7. Frequency Stability - The stability of Component "B" should be compatible with Component "A".

The receiver is also crystal controlled.

6.2.8. Channels - Six pre-set channels will be required.

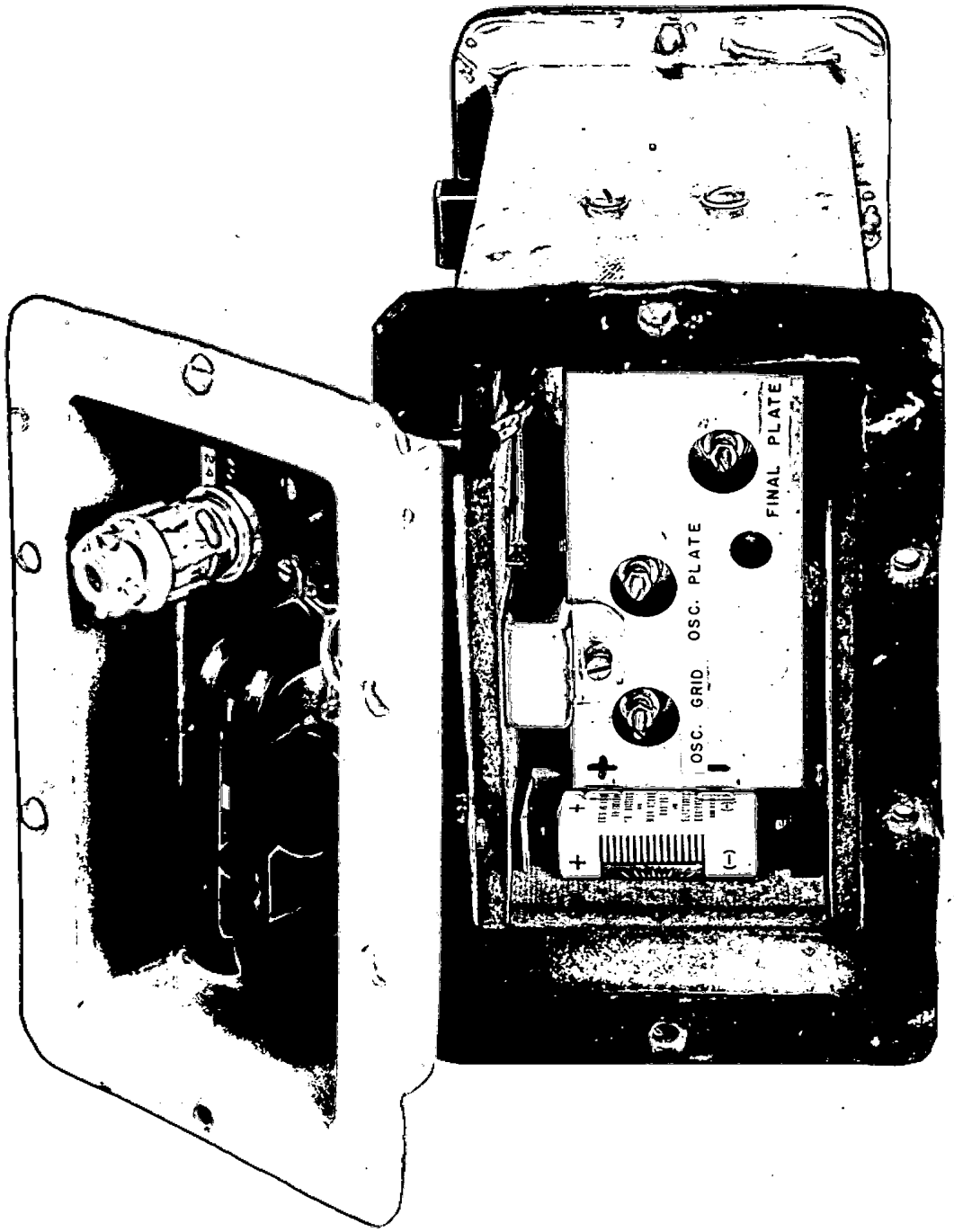
The receiver contains six pre-set channels. The desired channel is selected by means of an external control knob.

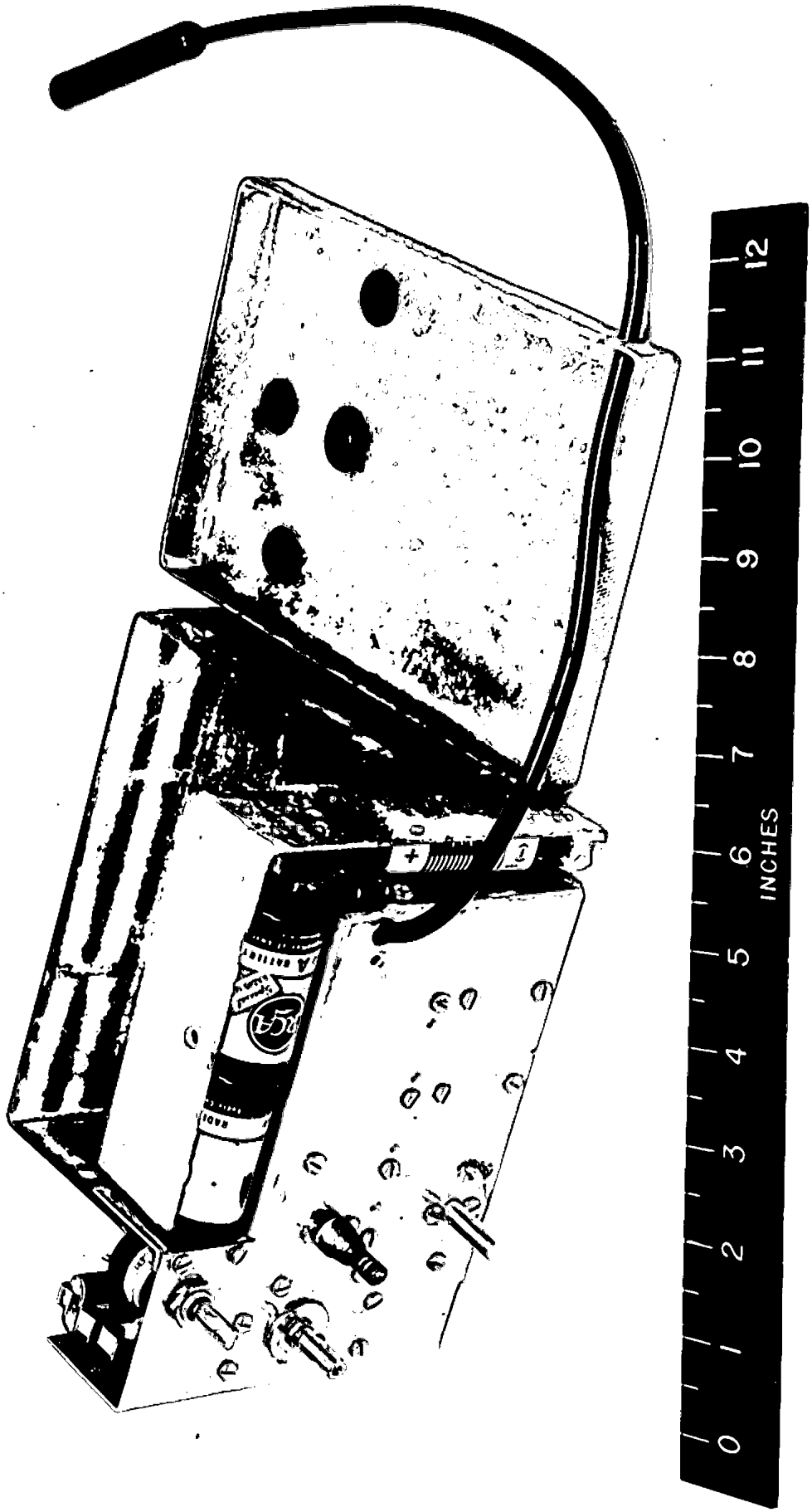
6.2.9. Construction - This unit is to be shower proof, fungus proof, tropicalized, and sterile in external appearance. A waterproof, corrosion resistant burial case is to be provided.

The unit is shower proof. The manufacturer states that future models will include fungus proofing and tropicalization. A false front cover will also provide sterility and burial capability.

6.2.10. Finish - The external finish is to be camouflaged and nonreflecting.

The unit is relatively camouflaged and non-reflecting.





4. CONCLUSION

The engineering model of the Cargo Chute Locator System RS-8 does not satisfactorily fulfill the requirements stated in its Task Outline. The prime requisite for the system is that it function satisfactorily over a quarter mile range under any conditions of terrain, weather, or time. The model supplied falls far short of this requirement. However, the system does possess some outstanding features. In general, the transmitter unit meets the Task Outline specifications. It provides a compact, rugged, "one-shot" unit. The signal produced is of sufficient power and omnidirectional. The receiver, however, appears to be deficient in sensitivity and over-all gain. The loop antenna is unidirectional but inefficient in its design. Similarly the head set provided is far below the recommended impedance for the audio tube used.

The system should prove satisfactory if an improved receiver unit is provided combining the present model's direction finding ability with a higher over-all gain.